



Clear text for revised application 10/042,626 March 24, 2005

What is claimed is:

1. A geometric design-to-build system for planet-type, backlash-free, roller-cyclo-gears and torque multiplier with the herewith patented key term "cyclo module" (similar to circular module for spur gears) which is identified by the letter "R" and stands for "the radius of the cyclo cylinder-like rounded tooth"(2); following are interrelated claims such as gear housing with utility channel throughputs; back drivable gears with low pressure angles that allow a high torque efficient power transmission with sealed-in lubricant; a constantly powered backlash-free rotary encoder; and one add-on anti-hunting electronic circuit that improves positioning and durability of the cyclo gear axis.
2. A cyclo module which represents one-half the theoretical diameter of the cyclo roller tooth (3.3) across its center: the individual roll tooth centers precisely locate at the theoretical cyclo planet wave disk roll diameter (2, 3.2) and at the cyclo gear roll diameter (1, 3.1) and identified as "D2" and "D1".
3. A cyclo wave tooth cap radius "r" (defined by three tangent points - two points are at adjacent roller tooth radii "R" and the third tangent point is at the precise theoretical roll diameter "D2" of the cyclo disk (2, 3.2)), is an important radius that influences the low gear pressure angle (8 to 19 degrees identified in Fig. 1.12, 1.13, 1.14), and impacts the tooth strength, and is an important characteristics of this patented design.
4. The pinion's eccentric's (3, 3.3) OFFSET is designated with "O" equals ($\frac{1}{2}$ "R") and the offset: determines the engagement depth of the cyclo wave disks (2, 3.2) to the cyclo gear (1, 3.1); controls the smooth, simultaneous constant rolling engagement of the 3 disks 720 degrees total cyclo teeth engagement; and secures a smooth, balanced and staple power torque transition.
5. The cyclo planet wave disk (2, 3.2) has: one less external roller tooth than the associated internal tooth cyclo gear (1, 3.1 and Fig.1.12, 1.13, 1.14); a theoretical design roll diameters derived by multiplying the standard cyclo module dimension "R" by the number of roll teeth designated here with Z1 and Z2; a transmission gear ration defined as revolutions IN to OUT and is defined as the number of cyclo gear teeth divided by minus one ($I = Z1 / (Z2 - Z1) = Z1 / -1$); samples of cyclo gear are shown with the lowest workable number of teeth, is $Z=3$ and an arbitrary number, is $Z=61$, as in Fig.1.11 and table 3; a range of cyclo modules and gear application can be sited: from hydraulic pumps and actuators; steam, gas, pneumatic powered rotary motors and compressors/superchargers, etc.

6. Three 120 degree maximum equally spaced eccentric drive pinions (3) are fitted with bearings into the opposing side flanges (4, 5); three backlash free planet gears (8) are mounted to the pinion (7) and are driven by the motor driveshaft mounted sun gear; three wave disk (2) are press fitted with frictionless bearings that roll on the eccentrics and transfer their motion force to the cyclo gear; pinions transfer the high torque to the side mounted flanges (4, 5); this design cyclo gear arrangement is backlash free and produces precision accuracy.

7. The cyclo equipped with three narrow equally-spaced cyclo disks are immune to dynamic load vector changes and harmonic vibrations, unlike wider one-disk or two-disk cyclo gears where the engaging variable gear teeth friction induces vibration which is worsened by either reacting dynamic vector load shifts or by relatively wide roll gear teeth spacing, and consequently flatter, larger contact angles.

8. The cyclo gear (1) is: mounted on bearings (10) between two opposing drive-out flanges (4, 5); kept in place by three incorporated large hollow, equally-distant stand-up spacers (4) and driven by three flange-to-flange reaching pinions (3) with eccentrics' and pinion gears (7), and are utilized to transfer the cyclo high torque rotation to the flanges (4, 5); self-contained is the lubrication sealed-in (15), backlash free, high torque cyclo gear axis or turn table with pass-through openings (3, 4, 9) for utility and encoder intelligence transmission cables, and the large center hole (9) is well placed for additional coaxial drive shafts throughputs.

9. One cyclo gear system with the following: only one center pinion on fitted bearings with three eccentrics (3.4); three press fitted needle bearings in the wave disks (3.2) which roll on the eccentrics that engage them with the cyclo gear (3.1); six or more equally maximum spaced and sized hollow torque stabilizing pins (3.5), fitted with frictionless nano magnetic-liquid-lubed sleeves and mounted between two opposing flanges (3,12) which transfer backlash free, the high torque to the tightly fitted and lubricated-sealed-in drive-out flanges (3.12), and the hollow stabilizing pins make it possible that auxiliary drive shafts, communication and power contactors are routed conveniently through the cyclo axis or turntable.

10. A pair of deep groove ball bearings or cross-roller bearings (10) are utilized to stabilize the high torque flanges to the cyclo gears by way of reset shoulder fits and retainers to make the cyclo gear assembly a stable axis or turntable for use in robots or other machine tools, in addition the flanges are equipped with fasteners and threaded attachment and index holes to make them align and attachable to other machines, fixture, and bases.

11. Included here and integral to the design are cyclo gear bodies made of soft metals or plastics that have inserted bearings and hardened cyclo teeth rollers (3.3), and cylindrical bushings, also offset-pins are fitted into cylindrical grooves or shouldered cylinder holes to distribute the high gear contact loads.

12. To enhance the cyclo rotating positioning accuracy further, an absolute constantly powered two-channel angular shaft encoder is fitted to the cyclo gear drive pinion or servo motor to make it an absolute position smart cyclo axis, which is connected to a constantly powered up-down counter that knows at any time its position, and does not lose its calibration data even on machine power off, whose data is constantly accessible by controllers or computers, and, if necessary, by internet or satellite anywhere in the world or universe.

13. A anti-hunting servo signal filter that enhances the performance of the cyclo torque multiplier and cyclo gear axis; it reduces and eliminates unwanted oscillating cyclic motion and consequently unwanted wear; however, susceptible to vibration are cyclo gears with one and two wave disks and cantilevered torque transfer output pins, also large cyclo tooth spacing with large pressure angles increase vibration and consequently wear; but vibration is made worse by amplified feedback summing circuit signals, as observed and as documented; in all this circumstances of shortcomings the anti-hunting circuit is doing an exemplary filter job and reduces vibration and wear and is an important claim in this patent.